VANDERBILT STUDENT VOLUNTEERS FOR SCIENCE
http://studentorgs.vanderbilt.edu/vsvs

Evidence of a Chemical Reaction

2018-2019 VINSE/VSVS Rural

Goal: To show students evidence of a chemical change.
Fits TN standards:

VSVSer Lesson Outline

_____ **I. Introduction**

Question students about the difference between physical and chemical changes. Explain what constitutes evidence of chemical reactions.

_____ **II. Safety Concerns**

Discuss safety issues. Demonstrate how students will use the small dispensing bottles and the 24-well culture plate.

_____ **III. Determining if a Chemical Change has Occurred**

Tell students to follow the instructions on the instruction sheet. You will still need to guide them through the procedures, making sure they understand the instructions. Discuss results with students after they finish each row. Chemical equations for Rows A, B, C are given.

_____ **Row A: Chemical Reactions That Give a Precipitate (solid)**

Students should realize that if the solution turns cloudy, a solid (precipitate) is forming.

_____ **Row B: Chemical Reactions That Involve a Color Change**

Formation of complex ions cause color changes.

----------**Row C: Chemical Reactions That Produce a Gas**

Students look carefully at the bubbles (CO_2) produced in solutions.

--------- **IV. Analyzing Results**

Emphasize the chemistry of carbonates and bicarbonates. Students predict the reaction between marble and HCl.

-------- **V. Review**

LOOK AT THE VIDEO BEFORE YOU GO OUT TO YOUR CLASSROOM (https://studentorg.vanderbilt.edu/vsvs/lessons/)
USE THE PPT AND VIDEO TO VISUALIZE THE MATERIALS USED IN EACH SECTION.

Materials

16 24-well culture plates with lids
16 plastic plates (to catch any spillage from well plates)
1 Demonstration Bag A - contains (1) 2 oz bottle of 0.1 M $CaCl_2$, (1) 2 oz bottle of 2.5 M Na_2CO_3, (2) 10 oz clear cups
1 Demonstration Bag B – contains (1) 2 oz bottle of 0.05 M $Na_2S_2O_3$, (1) 2 oz bottle of 0.01 M I_2 , (2) 10 oz clear cups
1 Demonstration Bag C - contains (1) 2 oz bottle of 1 M HCl, (1) jar of Na_2CO_3, (1) teaspoon, and (1) 10 oz clear cup
15 Ziploc bags containing the following:
6 plastic droppers (in a Ziploc bag) containing bottles of the following solutions

1.0 M	HCl	hydrochloric acid
2.5 M	Na_2CO_3	sodium carbonate

0.5 M $NaHCO_3$ sodium bicarbonate
0.1 M $Cu(NO_3)_2$ copper (II) nitrate
0.1 M $Fe(NO_3)_3$ iron (III) nitrate
0.1 M KSCN potassium thiocyanate

15 small pieces of marble $CaCO_3$ (in a small bag)

1 binder containing:
- 17 Instruction Sheets in sheet protectors (one per student)
- 34 Student observation sheets

1 pencil per student (Students should use their own pencils.)

2 sets of 1oz dropper bottles of each of the following unknowns:
- Unknown A: Na_2CO_3
- Unknown B: $CaCl_2$
- Unknown C: HCl
- Unknown D: KSCN
- Unknown E: $NaHCO_3$

Use these fun facts during the lesson:

- Chemical changes constantly occur in living organisms. The human body is made up of proteins that help catalyze complex chemical reactions.
- The products of a chemical reaction have the same total mass as the reactants (law of conservation of mass).

Unpacking the Kit – What you will need for each section:

- VSVSers do this while 1 person is giving the Introduction. Note that students are put into pairs and should have their pencils ready
- While one team member starts the introduction, another should write the following vocabulary words on the board:
  physical change, chemical change, chemical reaction, formula, solution, precipitate, compound, mixture

For Part III. Determining If a Chemical Change Has Occurred

34 safety goggles for students and VSVS members

16 24-well culture plates with lids

16 plastic plates

Instruction sheets, obs sheets

15 sets of dropper bottles of each:
- 1.0 M HCl hydrochloric acid
- 2.5 M Na_2CO_3 sodium carbonate
- 0.5 M $NaHCO_3$ sodium bicarbonate
- 0.1 M $Cu(NO_3)_2$ copper (II) nitrate
- 0.1 M $Fe(NO_3)_3$ iron (III) nitrate
- 0.1 M KSCN potassium thiocyanate

A. Demonstration Bag A – 2 oz bottle of 0.1 M $CaCl_2$, 2 oz bottle of 1 M Na_2CO_3, 2 10 oz clear cups 4 jars containing the products, with precipitate in bottom

B. Demonstration Bag B – 2 oz bottle of 0.05 M $Na_2S_2O_3$, 2 oz bottle of 0.01 M I_2 , 2 10 oz clear cups

Your Notes:

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C. Demonstration Bag C - 2 oz bottle of 1 M HCl, jar of Na_2CO_3, 1 teaspoon, and 1 10 oz clear cup

For Part IV. Analyzing Results

15 small pieces of marble $CaCO_3$ (in a small bag)

For Part V. Optional: Identifying an Unknown

2 sets of 1oz dropper bottles of each of the following unknowns: Unknown A: $NaHCO_3$ $_3$, Unknown B: $CaCl_2$, Unknown C: HCl, Unknown D: KSCN,

I. Introduction

Learning Goals: Students can name the different indicators that a chemical reaction has occurred.

Ask students: *What is the difference between a physical change and a chemical change?*
Be sure to include the following information in the discussion:

- **A physical change** does not change the chemical properties of a substance.
  - No new substance is formed during a physical change.
  - Only the physical properties are changed.
  - Examples of physical changes include changes in the size, shape, or state of matter. For example, ice, liquid water, and steam. In each of these states, water has physically changed (from solid, liquid, gas) but not chemically.
- **A chemical change** does change the chemical properties of a substance.
  - One or more new substances are formed in a chemical change.
  - A chemical change cannot be easily reversed.
  - Examples include: burning paper, digestion of food, bananas browning

Ask students: How can you tell when a chemical change has occurred? *Some answers may include: a gas given off, color change, precipitation, explosion, burning, etc.*

Tell students what to look for to determine if a chemical change has occurred:

When solutions of two compounds are mixed, it is often possible to determine whether or not a chemical reaction has occurred through visual observation.
Evidence of a chemical change might be **a color change**, **a gas given off (it may smell)**, the **formation of a precipitate (a new solid), or an energy (temperature, light) change.**

Write these observations on the board and share the following explanation with students.

1. A **color change** occurs when two solutions are mixed and a new color is produced.
   - BUT, if the color of one solution becomes a paler shade, that change is caused by dilution from the other solution and does not qualify as a color change.
2. Bubbles or fizz indicate that a **gas is given off**.
   - BUT, make sure that students understand that the bubbles given off in a soda pop drink is NOT evidence of a chemical change This is just excess gas that is released when the top is opened. Carbonated beverages contain carbon dioxide gas dissolved under pressure,

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and removing the top lowers the pressure and allows carbon dioxide bubbles to escape.

3. A **precipitate** forms when two substances react to give a new solid compound that does not dissolve in water.
    - A precipitate will MOST LIKELY look like a cloudy solution, fine grains in a solution, a swirl, or a fluffy solid. The solution cannot be seen through.

Note: When two clear solutions are mixed and a white precipitate forms, this whitish color does not count as a color change. The change should be recorded only as the formation of a precipitate.

4. **An energy change (temperature or light)** can be either a physical or chemical change. A chemical energy change occurs in a glow stick when chemicals mix to produces light. A physical energy change occurs when you freeze water.

Important: Scientists do not rely on just visual observations to determine if a chemical or physical change has occurred. **The only real evidence is the formation of new substances with different chemical formulas from the reactants.**

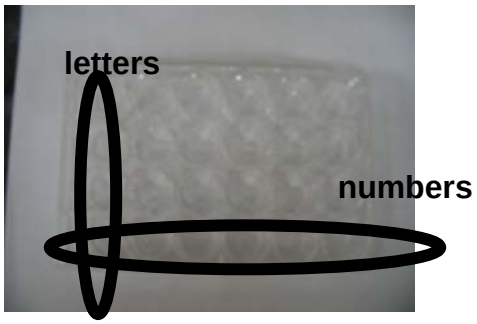
II. Safety Concerns

- Tell students they must put on safety goggles before mixing any solutions.
- Students should not directly smell any chemicals.
- If anyone gets any of the chemicals on their skin or in their eyes, they should flush immediately with water. Although the solutions are dilute, they could still cause eye damage, especially the 1.0 M HCl.
- Emphasize to students how important it is for them to follow directions.

Organize students in **pairs** and distribute the following materials to each pair of students:

2 safety goggles
1 24-well culture plate
1 plastic plate
6 dropper bottles of solutions
2 Instruction Sheets
2 Chemical Reactions Observation Sheets

- VSVS volunteers should put on their safety goggles and keep them on until students are finished mixing chemicals.
- Have students look at the 24-well plate and the instructions at the top of the Chemical Reactions Lab Sheet.
- Show students how to find the letters A, B, C, D as well as the numbers 1 - 6 on the 24-well plate. (Letters are imprinted in the plastic along the right side; numbers are imprinted across the top and the bottom. These are tiny and may be difficult to see.)



- Show students how to **match the grid on the lab sheet to the 24-well plate**. Tell students to place the 24-well plate on the plastic plate.

Give the following instructions to the students:

1. The names and formulas of the compounds being used in this experiment are listed at the bottom of the observation sheet.

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Have students look at these names and formulas while you pronounce them for the class.
The labels on the dropper bottles list both the name and formula.
of the compounds.
Show students how to be careful when matching the formulas (some of the formulas are very similar)**.**

2. Show students one of the bottles and demonstrate how to get drops out of the bottle. Dropper bottles are easy to use. Apply slow, gentle pressure. Do not remove the red cap from a bottle until it is to be used. Put the cap back on the bottle immediately after use.
When using two solutions, put a squirt of the first solution in the correct well so that it is one-fourth full (we do not want students to spend time counting drops). Then add one squirt of the second solution. The well should now be half full.

3. Tell students they will perform the reactions for one row only then stop and discuss the results with the VSVS members. Tell the partners to take turns doing the experiments as they follow the grid on the lab sheet. Both students record their observations on the lab sheet. Students can record NR if No Reaction occurs. Otherwise, they will record color change, gas given off, or precipitate formed.

4. **Tell students to follow the instructions on the instruction sheet for mixing solutions.** (The instruction sheet lists the same directions as are given below.)

III. Determining If a Chemical Change Has Occurred

Learning Goals:

- **Students can name the different indicators that a chemical reaction has occurred.**
- **Students can identify the specific indicators of a reaction and explain how to look for them**

One team member should draw a grid of the well plate on the board with all of the rows labeled. Write on this when discussing the results with the students.

Note: VSVS volunteers need to monitor the students closely to be sure contamination does not occur. Ensure that students use the correct bottle.

Stop and discuss results with students after each row. This is preferable to waiting until students finish all of the experiment since some will finish very quickly and then be bored waiting for others to catch up.

The beginning of each reaction is given on the student observation sheet. Students and VSVSers should complete each equation on the board after the reactions in each row are completed.

A. Chemical Reactions that Give Precipitates - Row A

Demonstration: Show students what a precipitate looks like by doing the following demonstration.
Take the demonstration bag marked ROW A. Remove the 2 oz bottles of solutions and the two 10 oz clear cups. Empty each 2 oz bottles into separate cups. Hold the two cups up so the students can see

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happens, and then pour one solution into the other. A solid (precipitate) forms. Point

example of a chemical reaction which a precipitate forms to students.

Show the students the jars with the clear liquid and precipitate in the bottom. Tell them that these are the products from the same reaction just done, but the products were allowed to stand for several hours. Shake the jar to show the students that the solution will become cloudy again.

Tell students to use the grid on their observation sheet to perform the experiments in Row A. Make sure that they correctly identify the formulas of the compounds being used in a reaction (listed on the observation sheet).

> **Note:** For each activity **DO NOT** record the results until the students have completed the experiments for the row since they may wait to copy the answers from the board.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
  - *A precipitate formed in A1 and A2.*
- Put the results on the board. ***A1:*** *precipitate* ***A2:*** *precipitate*
- Students can look at the equations on the observation sheet:

Demo: $CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2\ NaCl$

A1: $2\ Fe(NO_3)_3 + 3\ Na_2CO_3 \rightarrow Fe_2(CO_3)_3 + 6\ NaNO_3$

A2: $Cu(NO_3)_2 + Na_2CO_3 \rightarrow CuCO_3 + 2\ NaNO_3$

B. Chemical Reactions that Involve a Color Change - Row B

Demonstration: Show students what a color change looks like by doing the following demonstration.

- Take the demonstration bag marked ROW B. Remove the 2 oz bottles of solutions and the two 10oz clear plastic cups. Empty each 2 oz bottles into separate cups. Hold the two clear containers up, and tell students to notice that one is a clear colorless solution and the other is a

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clear, brown solution. Pour the colorless solution into the brown solution, and ask students to describe what happens. The brown solution turns colorless, but it is still clear (i.e no precipitation). Explain to students that a chemical reaction has taken place because the brown solution turned colorless upon addition of the clear solution.

- Tell students to use the grid on the lab sheet to perform the experiments in Row B.

Background for VSVS Members Only: This is an oxidation-reduction reaction in which iodine is reduced to iodide ion, and thiosulfate ion, $S_2O_4^{2-}$, is oxidized to tetrathionate ion, $S_4O_6^{2-}$.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
  - A color change occurred.
- Put the results on the board. ***B1:*** *color change to deep red* ***B2:*** *color change to pale green.*

Students can look at the equations on their observation sheet.

Demo: $I_2 + 2\ Na_2S_2O_3 \rightarrow 2\ NaI + Na_2S_4O_6$

B1: $Fe(NO_3)_3 + KSCN \rightarrow Fe(SCN)(NO_3)_2 + KNO_3$ (intense red color)

B2: $Cu(NO_3)_2 + KSCN \rightarrow Cu(SCN)(NO_3) + KNO_3$ (pale green color)

Background for VSVS Members Only: Color changes with metal ion solutions are caused by the formation of complex ions. In the present case, the SCN^- (thiocyanate) anion bonds strongly to the Fe^{3+} (iron) ion in solution to give an intense deep red color. The SCN^- anion also bonds to Cu(II) (copper) ion.

C. Chemical Reactions that Produce a Gas - Row C

Note: Tell students they will have to look very closely and quickly as soon as they add the second solution to the first solution. The bubbles of gas are small and come off as soon as the solutions are mixed.

Demonstration: Show students what a chemical change that produces a gas looks like by performing the demonstration first.

Take the demonstration bag marked ROW C. Hold the cup up and ask students to watch very carefully what happens.

Put 1 tsp of the solid (Na_2CO_3) into the cup and empty the 2oz bottle (HCl) into it.

Ask students to describe what happens.

A bubbling up (slight foaming) which quickly subsides indicates a gas is given off. Tell students to watch very carefully for bubbles of gas when they are doing **Row C** because they may be difficult to see.

- Tell students to use the grid on the lab sheet to perform all the experiments in Row C.

Review and Equations:

- Ask students what evidence indicated that a chemical reaction occurred.
  - *Bubbles/gas was given off.*
- Put the results on the board. ***C1:*** *bubbles/gas* ***C2:*** *bubbles/gas*

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- Students can look at the equations on the observation sheet.

  Demo: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$

  C1: $NaHCO_3 + HCl \rightarrow NaCl + CO_2\,(g) + H_2O$

  C2: $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2\,(g) + H_2O$

IV. Analyzing Results

Learning Goals: Students can analyze compounds' reactions with one another and use that data to identify an unknown compound.

Carbonates:

- Write CO_3 on the board and tell students that formulas that include "CO_3" as part of the formula are called **carbonates**.
- One form of carbonate, sodium carbonate is commonly referred to as "washing soda." It is part of many laundry detergents and dish washing detergents.
- Tell students to look at the ingredients of the copy of a **washing soda box on their Instruction sheet.** Sodium carbonate is listed as an ingredient.

Bicarbonates:

- Write HCO_3 on the board and tell students that formulas that include "HCO_3" as part of the formula are called **bicarbonates**.
- A common source of bicarbonate is **baking soda**, whose scientific name is sodium bicarbonate. Sodium bicarbonate is used for baking and as a deodorizer. Tell students to look at the ingredient label on baking soda and notice it says **sodium bicarbonate**.

Reactions of Carbonates and Bicarbonates:

- Ask students to look at each box in row C and circle the formulas that have "CO_3" or "HCO_3" as part of the formula. .
- Write HCl on the board.
  - Tell students that HCl is an acid called hydrochloric acid.
  - Tell students to put boxes around all the HCl's in Row C
- Ask students what happened in row C when an acid was added to a carbonate or bicarbonate.
  - *A gas was given off.*
  - Ask students if they have ever made a "volcano" at home or at school. Ask students if they remembered what they added to make the "lava". Most likely, they used vinegar and baking soda. Vinegar is an acid, and when added to baking soda (sodium bicarbonate), it bubbles as it releases a gas.
- Ask students what happens when you add an acid to carbonate or bicarbonate. *When an acid is added to a carbonate or bicarbonate a **chemical reaction occurs**. This is evidenced by the fact that a gas is given off.*
- Tell students that the gas given off in these reactions is carbon dioxide.

Identifying Carbonates Using Chemical Reactions:

- Tell students that chalk, limestone and marble are all calcium carbonate. If the formula for

Your Notes:

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calcium carbonate is $CaCO_3$, what might happen if an acid (HCl) is added to marble? *It will bubble (give off a gas).*

- Write the first half of the equation, $CaCO_3$ (s) + HCl (aq) → ...on the board, and ask students to hypothesize what will happen, and what the products will be. ***The gas will be CO_2.***

The full equation is:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

- Have VSVS members hand out a piece of marble to each pair of students. Tell students that they are going to test their hypothesis to see if the marble will bubble when HCl is added.
- Have students add the marble to C5 and to squirt some HCl into the well. Ask students what happened. Was their hypothesis correct? *Yes, it should bubble when HCl is added.*
- Tell students that many statues are made of limestone and marble. Ask students what they think happens to statues when acid rain falls on them. *The carbonate in the statue reacts with acid liberating a gas and causing the statue to decompose.*

Background Information (in case students ask about acid rain): Acid rain is caused by the presence of varying amounts of sulfuric acid and nitric acid in rain drops. Fossil fuels, particularly coal and oil, contain sulfur as an impurity. When fossil fuels are burned, the sulfur combines with oxygen to form sulfur oxides that are gases released into the air. When it rains, the water reacts with these gases to form sulfuric acid. When vehicles burn gasoline or diesel fuel, nitrogen oxides are emitted into the air, and these react with water to produce nitric acid. The amount of sulfuric acid and nitric acid in acid rain depends on the location. The acid rain in Nashville is primarily caused by nitric acid from the high density of vehicles, while the acidity of rain in industrialized areas will be caused by the presence of both sulfuric and nitric acids. As a result of the Clean Air Act, industrial and power plants are emitting much lower amounts of sulfur oxides; however, the emission of nitric oxides from vehicle exhausts is still a problem.

V. Optional: Identifying an Unknown

Tell students they will be given a colorless solution that contains one of the following compounds dissolved in water

Unknown A: $NaHCO_3$
Unknown B: $CaCl_2$
Unknown C: HCl
Unknown D: KSCN

These are the same colorless solutions that they have been doing the experiments with, except that $CaCl_2$ was used only in Demonstration A.

Tell them that they will follow a plan, using the dropper bottles from the chemical reaction kit, to determine the identity of the unknown.

Students can work in pairs, groups, or as a class.

Distribute the 8 unknown dropper bottles throughout the class, so that pairs or groups of students have access to one unknown.

Tell students to:

Your Notes:

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1. Follow the plan in Row D and add a squirt of their unknown to the 6 wells in Row D of the well plate.
2. Add a few drops from their known dropper bottles, one well at a time.
3. Write down the observation immediately after each addition.
4. Look at the results in Rows A, B and C, including the demonstration reactions, to determine what the possible reactions are.

Ask students: What do you think your unknown is? _____

What is your proof for what you've listed in (a)?

The proof should be stated something like the answer response in the plans given above but specific for the unknown. For example, if the unknown was $CaCl_2$, the proof statement could be: A precipitate formed when Na_2CO_3 solution was added. The $CaCl_2$ solution is the only one of the possible unknowns that will give a precipitate with Na_2CO_3.

Write balanced chemical equations for the reactions you used to determine the identity of the unknown. (**Refer to equations in lesson (Section VIII))**

Optional: Answer these questions after finishing the chemical reactions observation sheet.

1. Write complete, balanced equations for the following:
   a. One reaction in Row A that gave a precipitate.
      Refer to equations in lesson (Section VIII)
   b. One reaction in Row B that gave a color change.
      Refer to equations in lesson (Section VIII)
   c. One reaction in Row C that gave a gas.
      Refer to equations in lesson (Section VIII)

VI. Review Questions

Ask students**:**

- What is a physical change?
- What is a chemical change?
- How do we know when a chemical change has occurred? (answer on p. 3)

VII. Clean-up

- Have students put the dropper bottles back in the Ziploc bag. **Make sure that the bottles are all upright. Leaks make for nasty clean-up tasks.**
- Collect the Ziploc bags and the goggles.
- Place the lids on the 24-well plates and carefully put them in the Rubbermaid container. Place the lid on the Rubbermaid container and put it in the bottom of the box. (If you can rinse them out at the school, do so, PLEASE)
- Place the ziploc bags and other materials in the box.
- Collect all instruction sheets in sheet protectors and put them in the box.

Lesson written by Dr. Melvin Joesten, Chemistry Department, Vanderbilt University
Pat Tellinghuisen, Coordinator of VSVS, Vanderbilt University

Your Notes:

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Class Activity Sheet – Extension Activity

NAME _____

1. You will be given an unknown colorless solution that contains one of the following compounds dissolved in water: $CaCl_2$, KSCN, HCl, $NaHCO_3$. Follow Row D to determine the identity of your unknown.
   a. What do you think your unknown is? _____ If there is more than one possibility, list both.

   b. What is your proof for what you've listed in (a)?

   c. Write balanced chemical equations for the reactions you used to determine the identity of the unknown.

1. Write complete, balanced equations for the following (choose a correct equation from the list below):
   a. One reaction in Row A that gave a precipitate.

   b. One reaction in Row B that gave a color change.

   c. One reaction in Row C that gave a gas.

Chemical Equations for Chemical Reactions in this Lesson

Abbreviations: s = solid, aq = aqueous, g = gas, l = liquid

$CaCl_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CaCO_3\ (s) + 2\ NaCl\ (aq)$

$2\ Fe(NO_3)_3\ (aq) + 3\ Na_2CO_3\ (aq) \rightarrow Fe_2(CO_3)_3\ (s) + 6\ NaNO_3\ (aq)$

$Cu(NO_3)_2\ (aq) + Na_2CO_3\ (aq) \rightarrow CuCO_3\ (s) + 2\ NaNO_3\ (aq)$

$I_2(aq) + 2\ Na_2S2O_3(aq) \rightarrow 2\ NaI(aq) + Na_2S_4O_6\ (aq)$

$Fe(NO_3)_3\ (aq) + KSCN\ (aq) \rightarrow Fe(SCN)(NO_3)_2\ (aq) + KNO_3\ (aq)$

$Cu(NO_3)_2\ (aq) + KSCN\ (aq) \rightarrow Cu(SCN)(NO_3)\ (aq) + KNO_3\ (aq)$

$Na_2CO_3\ (s) + 2HCl\ (aq) \rightarrow 2NaCl\ (aq) + CO_2\ (g) + H_2O\ (l)$

$NaHCO_3\ (aq) + HCl\ (aq) \rightarrow NaCl\ (aq) + CO_2\ (g) + H_2O\ (l)$

$Na_2CO_3\ (aq) + 2HCl\ (aq) \rightarrow 2NaCl\ (aq) + CO_2\ (g) + H_2O\ (l)$

$CaCO_3\ (s) + 2HCl\ (aq) \rightarrow CaCl_2\ (aq) + CO_2\ (g) + H_2O\ (l)$

Your Notes:

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Class Activity Sheet
ANSWER SHEET

Answer these questions after finishing the chemical reactions observation sheet.

2. Write complete, balanced equations for the following:
    a. One reaction in Row A that gave a precipitate.
    Refer to equations on worksheet
    One reaction in Row B that gave a color change.
    Refer to equations on worksheet
    One reaction in Row C that gave a gas.
    Refer to equations in lesson (Section VIII)

2. 2. You will be given an unknown colorless solution that contains one of the following compounds dissolved in water: $CaCl_2$, KSCN, HCl, $NaHCO_3$. Follow Row D to determine the identity of your unknown.

What do you think your unknown is? _____

5. What is your proof for what you've listed in (a)?

The proof should be stated something like the answer response in the plans given above, but specific for the unknown. For example, if the unknown was $CaCl_2$, the proof statement could be: A precipate formed when $NaHCO_3$ solution was added. The $CaCl_2$ solution is the only one of the possible unknowns that will give a precipitate with $NaHCO_3$.

6. Write balanced chemical equations for the reactions you used to determine the identity of the unknown.

Refer to equations below

Your Notes:

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Chemical Reactions Observation Sheet

Name_____

Vocabulary Words: physical change, chemical change, chemical reaction, formula, **solution, precipitate, compound, mixture**

In each box, use the following choices to record your observations: color change, precipitate formed, gas given off, NR (no reaction)
Add other observations if you wish. Ex: lots of bubbles, fizz, small or large bubbles, cloudy precipitate.

A1 $Fe(NO_3)_3$ + Na_2CO_3	**A2** $Cu(NO_3)_2$ + Na_2CO_3	**A3**	**A4**	**A5**	**A6 Demonstration** $CaCl_2$ + Na_2CO_3	$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$ $2\ Fe(NO_3)_3 + 3\ Na_2CO_3 \rightarrow Fe_2(CO_3)_3 + 6\ NaNO_3$ $Cu(NO_3)_2 + Na_2CO_3 \rightarrow CuCO_3 + 2\ NaNO_3$
B1 $Fe(NO_3)_3$ +KSCN	**B2** $Cu(NO_3)_2$ +KSCN	**B3**	**B4**	**B5**	**B6 Demonstration** $I_2 + 2Na_2S2O_3$	$I_2 + 2\ Na_2S_2O_3 \rightarrow 2\ NaI + Na_2S_4O_6$ $Fe(NO_3)_3 + KSCN \rightarrow Fe(SCN)(NO_3)_2 + KNO_3$ $Cu(NO_3)_2 + KSCN\ (aq) \rightarrow Cu(SCN)(NO_3) + KNO_3$
C1 $NaHCO_3$ + HCl	**C2** Na_2CO_3 + HCl	C3	C4	C5 marble solid $CaCO_3$ + HCl	**C6 Demonstration** $Na_2CO_3 + 2HCl$	$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ $NaHCO_3 + HCl \rightarrow NaCl + CO_2 + H_2O$ $Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2 + H_2O$ $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$
D1 $NaHCO_3$ + unknown	**D2** KSCN + unknown	**D3** $Fe(NO_3)_3$ + unknown	**D4** $Cu(NO_3)_2$ + unknown	**D5** HCl + unknown	**D6**	

HCl - hydrochloric acid Na_2CO_3 - sodium carbonate $NaHCO_3$ - sodium bicarbonate $Cu(NO_3)_2$ - copper (II) nitrate $Fe(NO_3)_3$ - iron (III) nitrate
KSCN - potassium thiocyanate $CaCl_2$ - calcium chloride

Chemical Reactions Lab Sheet
Answer Key

A1 $Fe(NO_3)_3 + Na_2CO_3$ precipitate	**A2** $Cu(NO_3)_2 + Na_2CO_3$ precipitate	**A3**	**A4**	**A5**	**A6** **Demonstration** $CaCl_2 + Na_2CO_3$ white precipitate
B1 $Fe(NO_3)_3$ +KSCN color change- deep red	**B2** $Cu(NO_3)_2$ +KSCN color change - pale green color	**B3**	**B4**	**B5**	**B6** **Demonstration** $I_2 + 2\ Na_2S2O_3$ color change – brown to colorless
C1 baking soda $NaHCO_3$ + HCl gas given off	**C2** washing soda Na_2CO_3 + HCl gas given off	**C3**	**C4**	**C5** marble solid $CaCO_3$ + HCl gas given off	**C6** **Demonstration** Na_2CO_3 + 2HCl gas given off
D1 baking soda $NaHCO_3$ + unknown	**D2** potassium thiocyanate KSCN + unknown	**D3** iron nitrate $Fe(NO_3)_3$ + unknown	**D4** copper nitrate $Cu(NO_3)_2$ + unknown	**D5** hydrochloric acid HCl + unknown	**D6**

HCl - hydrochloric acid Na_2CO_3 - sodium carbonate $NaHCO_3$ - sodium bicarbonate $Cu(NO_3)_2$ - copper (II) nitrate $Fe(NO_3)_3$ - iron (III) nitrate
KSCN - potassium thiocyanate $CaCl_2$ - calcium chloride

Answer Sheet for Unknown Solutions

baking soda $NaHCO_3$ + **unknown A (Na_2CO_3)** NR	potassium thiocyanate KSCN+ **unknown A (Na_2CO_3)** NR	iron nitrate $Fe(NO_3)_3$+ **unknown A (Na_2CO_3)** PPT	copper nitrate $Cu(NO_3)_2$+ **unknown A (Na_2CO_3)** PPT	hydrochloric acid HCl + **unknown A (Na_2CO_3)** Gas given off	
baking soda $NaHCO_3$ + **unknown B ($CaCl_2$)** PPT	potassium thiocyanate KSCN+ **unknown B ($CaCl_2$)** NR	iron nitrate $Fe(NO_3)_3$+ **unknown B ($CaCl_2$)** NR	copper nitrate $Cu(NO_3)_2$ + **unknown B ($CaCl_2$)** NR	hydrochloric acid HCl + **unknown B ($CaCl_2$)** NR	
baking soda $NaHCO_3$ + **unknown C (HCl)** Gas given off	potassium thiocyanate KSCN + **unknown C (HCl)** NR	iron nitrate $Fe(NO_3)_3$ + **unknown C (HCl)** Color change	copper nitrate $Cu(NO_3)_2$ + **unknown C (HCl)** Color change	hydrochloric acid HCl + **unknown C (HCl)** NR	
baking soda $NaHCO_3$ + **unknown D (KSCN)** NR	potassium thiocyanate KSCN + **unknown D (KSCN)** NR	iron nitrate $Fe(NO_3)_3$ + **unknown D (KSCN)** Color change	copper nitrate $Cu(NO_3)_2$ + **unknown D (KSCN)** Color change	hydrochloric acid HCl + **unknown D (KSCN)** NR	
baking soda $NaHCO_3$ + **unknown E ($NaHCO_3$)** NR	potassium thiocyanate KSCN + **unknown E ($NaHCO_3$)** NR	iron nitrate $Fe(NO_3)_3$ + **unknown E ($NaHCO_3$)** PPT	copper nitrate $Cu(NO_3)_2$ + **unknown E ($NaHCO_3$)** PPT	hydrochloric acid HCl + **unknown E ($NaHCO_3$)** Gas given off	

Instruction Sheet

Evidence of a Chemical Reaction 8th Grade

Important:

- Always wear safety goggles when dealing with chemicals
- Pay close attention to which solutions you are using
- To use dropper bottles apply slow, gentle pressure
- Don't fill more than halfway full
- **Record observations: NR = no reaction, PPT= precipitate, color change, gas formed**

Chemical Name	**Chemical Formula**
1. Iron III Nitrate	$Fe(NO_3)_3$
2. Copper Nitrate	$Cu\ (NO_3)_2$
3. Sodium Carbonate	Na_2CO_3
4. Potassium Thiocyanate	KSCN
5. Sodium Bicarbonate	$NaHCO_3$
6. Hydrochloric Acid	HCl

I. Setting Up

A. Receive and put on safety goggles

B. Materials

1. First set of solutions
2. 24 well plate
3. plastic plate (place well plate on plastic plate)
4. Observation Sheet

III A. Row A -Precipitate

C. Watch VSVS members complete Demo A

D. What you need:

1. **$Fe(NO_3)_3$ ---> squirt into well A1, ¼ full**
2. **$Cu(NO_3)_2$ ---> squirt into well A2, ¼ full**
3. **Na_2CO_3 ----> squirt into both A1 and A2 until ½ full**

C. Record your observations for each well on your observation chart.

D. Wait for instructions from VSVS member before moving on

III. B Row B – Color Change

A. Watch VSVS members complete Demo B

B. What you need

1. **$Fe(NO_3)_3$ ---> squirt into well B1, ¼ full**
2. **$Cu(NO_3)_2$ ----> squirt into well B2, ¼ full**
3. **KSCN ----> squirt into both B1 and B2 until ½ full**

C. Record your observations for each well on your observation chart.

D. Wait for instructions from VSVS members before moving on

III. Row C – Produce a Gas

A. Watch VSVS members perform Demo C

B. What you need

1. **$NaHCO_3$ ---> squirt into well C1, ¼ full**
2. **Na_2CO_3 ----> squirt into well C2, ¼ full**
3. **HCL ---> squirt into both C1 and C2 until ½ full**

C. Record your observations for each well on your observation chart

D. Wait for instructions from VSVS members before moving on.

IV. Analyzing the Results – Carbonates and Bicarbonates

A. Discuss results with the class or small groups

B. Predict what will happen if marble and an acid interact?

1. Receive a piece of marble from VSVS member
2. **Place marble in well C5**
3. **Add a few drops of HCL**
4. Record observations

V. Optional – Identifying an Unknown

A. Receive an unknown solution from VSVS member

B. Record which unknown you are given on your observation sheet

C. Squirt unknown into wells D1 - D6 until ¼ full

1. **D1** ---> squirt **$NaHCO_3$**, until ½ full
   a. Record Observations for each cell immediately after addition.
2. **D2** ---> squirt **Na_2CO_3**, until ½ full
3. **D3** --->squirt **KSCN**, until ½ full
4. **D4** ---> squirt **$Fe(NO_3)_3$**, until ½ full
5. **D5** ---> squirt **$Cu(NO_3)_2$,** until ½ full
6. **D6** ---> squirt **HCl**, until ½ full

D. Determine which solution your unknown is (ask VSVS member if you need help

VII. Clean- Up

A. Place red caps on all the dropper bottles

B. Give goggles back to VSVS members

C. Wash off the well plates if available